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IS 10596-3 (1983): Code of practice for selection, installation, operation and maintenance of pumps for industrial applications, Part 3: Operation [MED 20: Pumps]



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“Knowledge is such a treasure which cannot be stolen”

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Indian Standard

(Reaffirmed 2002)

CODE OF PRACTICE FOR SELECTION, INSTALLATION, OPERATION AND MAINTENANCE OF PUMPS FOR INDUSTRIAL APPLICATIONS

PART 3 OPERATION

1. Scope — Lays down the broad guidelines for operation of pumps for industrial applications.

1.1 This standard is not applicable for pumps for agricultural applications.

2. Operation

2.1 Before starting a pump for the first time within a new system, the check list as given in Appendix A shall be filled up by engineers incharge to ensure that the pump and its main and auxiliary piping has been erected with the best technical proficiency.

2.2 Generally, pumps are selected for certain characteristics referred to as 'rated service conditions' and with a few exceptions, represent those conditions at or near which the pumps will operate the major part of the time. Positive displacement pumps can not operate at flows greater than rated except by increasing their speed, nor can they operate at lower flows except by reducing the operating speed or by-passing some of the flow back to the source of supply.

2.3 Contrary to above, centrifugal pumps can operate over a wide range of capacities, from near zero to well beyond the rated capacity. Since a centrifugal pump will always operate at the intersection of its head volume rate of flow curve with system head curve, the pump's operating volume rate of flow may be altered either by throttling the pump volume rate of flow (hence altering the system head curve) or by varying the pump speed (changing the pump head-volume rate of flow curve). This makes the centrifugal pump very flexible in a wide range of services and applications which require the pump to operate at volume rate of flow and heads differing considerably from the rated conditions. There are, however, some limitations imposed upon such operation by hydraulic, mechanical or thermodynamic considerations.

2.4 Volute pumps should adhere to the limitations on the minimum recommended flow for sustained operation given by the manufacturer due to radial thrust and recirculation problems. The operation of a centrifugal pump at extremely reduced flows causes heating up of the fluid being handled by the pump. This is due to the conversion of work energy available to the impeller into heat energy. Where the pump handles cold water, the temperature rise may be permitted to reach 10°C or even 20°C. Hence the minimum safe continuous volume rate of flow based on thermodynamic consideration is then established as that volume rate of flow at which the temperature rise corresponds to the maximum permitted.

2.5 Hydraulic considerations are also there which may affect the minimum flow at which centrifugal pump may be permitted to operate. A correlation has been developed between operation at low flows and the appearance of hydraulic pulsations both in the suction and in the discharge of centrifugal impellers. It has been found out that these pulsations are caused by the development of an internal recirculation at the inlet and discharge of an impeller at flows below the volume rate of flow at best efficiency. Recommendations of the pump manufacturer about minimum flows, dictated by hydraulic considerations should be followed.

2.6 If the service conditions call for a pump to operate at shut off or a extremely low flows, means should be provided to prevent pump operation below minimum permissible flows regardless of whether the discharge valve or check valve is closed. This is accomplished by installing a bypass flow to the desired volume. When the differential pressure to be broken down by the orifice is relatively low, a single drilled orifice in a 75 to 150 mm stainless steel rod may be used. An elbow should never be located too close to an orifice. The pipe plug at the end of the coupling should be made of stainless steel.

3. Priming

3.1 Except a few exceptions, all centrifugal pumps need priming before they are started. Priming refers to filling up the suction piping and pump casing with the liquid to be handled and allowing the

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air or gas contained in the pump to escape. The exceptions are self-priming pumps and some special large volume rate of flow, low head, and low-speed installations where it is not practical to prime the pump prior to starting. In the case the priming takes place almost simultaneously with the starting of the pump.

3.2 Reciprocating pumps are in principle self-priming. However, if quick starting is required, priming connections should be piped to a supply above the pump.

3.3 Rotary type pumps have clearances and the liquid in the pump drains back to the suction when pumping low viscosity liquids. The pump may completely dry out when it is idle. In such cases a foot valve may be used to help keep the pump primed or a vacuum device may be used to prime the pump. When handling liquids of high viscosity, foot valves are usually not required as the liquid is retained within the clearances and act as a seal when the pump is restarted. However, before the initial start of a rotating-type positive displacement pump, some of the liquid to be pumped should be introduced through the discharge side of the pump to wet the rotating element.

4. Lubrication

4.1 Before starting the pump for the first time the bearing covers should be removed and bearings shall be thoroughly cleaned in accordance with manufacturer's recommendations. They should then be filled with new lubricant in accordance with the manufacturer's recommendations.

5. Starting and Stopping Procedures

5.1 The necessary steps in the starting of a centrifugal pump will depend upon its type and the service for which it is installed. For example, standby pumps are generally held ready for immediate starting. The isolating and discharge valves are held open and reverse flow through the pump is prevented by the discharge valve in the discharge line.

5.2 The methods followed in starting are greatly influenced by the shape of the power — volume-rate-of-flow curve of the pump. High and medium-head pumps (low and medium specific speeds) have power curves that rise from zero flow to the normal volume rate of flow condition. Such pumps should be started against a closed discharge valve to reduce the starting load on the prime mover. A check valve is equivalent to a closed valve for the purpose, as long as another pump is already on the line. The check valve will not lift until the pump being started comes up to a speed sufficient to generate a head high enough to lift the check valve from its seat. If a pump is started with a closed discharge valve, the recirculation bypass line must be open to prevent overheating.

5.3 Low-head pumps (high specific speed) of the mixed-flow and propeller type have power curves rising sharply with a reduction in capacity and should be started with the discharge valve wide open against a check valve if required, to prevent backflow.

5.4 Assuming that the pump in question is motor-driven, that its shut-off power does not exceed the motor power, and that it is to be started against a closed discharge valve, the starting procedure should be as follows :

- a) Prime the pump, opening the isolating valve, closing the drains, etc, to prepare the pump for operation,
- b) Open the valve in the cooling-water supply to the bearings, where applicable;
- c) Open the valve in the cooling-water supply if the stuffing boxes are water-cooled;
- d) Open the valve in the sealing-liquid supply if the pump is so fitted;
- e) Open the warm-up valve of a pump handling hot liquid if the pump is not normally kept at operating temperature. When the pump is warmed up, close the valve;
- f) Open the valve in the recirculating line if the pump should not be operated against dead shut-off;
- g) Start the motor;
- h) Open the discharge valve slowly;
- j) Observe the leakage from the stuffing boxes and adjust the sealing-liquid valve for proper flow to ensure the lubrication of the packing. If the packing is new, do not tighten up on the gland immediately, but let the packing run in before reducing the leakage through the stuffing boxes;
- k) Check the general mechanical operation of the pump and motor; and
- m) Close the valve in the recirculating line once there is sufficient flow through the pump to prevent overheating.

5.5 If the pump is to be started against a closed check valve with the discharge valve open, the steps would be the same, except that the discharge valve would be opened some time before the motor is started.

5.6 In certain cases the cooling water to the bearings and the sealing water to the seal cages are provided by the pump itself. This, of course, eliminates the need for the steps listed for the cooling and sealing supply.

5.7 Just as in starting a pump, the stopping procedure depends upon the type and service of the pump. Generally the steps followed to stop a pump which can operate against a closed gate valve would be:

- a) Open the valve in the recirculating line;
- b) Close the discharge valve;
- c) Stop the motor;
- d) Open the warm-up valve if the pump is to be kept up to operating temperature;
- e) Close the valve in the cooling-water supply to the bearings and to water-cooled stuffing boxes;
- f) If the sealing liquid supply is not required while the pump is idle, close the valve in this supply line; and
- g) Close the suction valve, open the drain valves, etc, as required by the particular installation or if the pump is to be opened up for inspection.

5.7.1 If the pump is of a type which does not permit operation against a closed discharge valve, steps (b) and (c) are reversed.

5.8 In general, the starting and stopping of steam turbine-driven pumps required the same steps and sequence prescribed for a motor-driven pump. As a rule, steam turbines have various drains and seals which must be opened or closed before and after operation. Similarly, many turbines require warming up before starting. Finally some turbines require turning-gear operation if they are kept on the line ready to start up. The operator should, therefore, follow the steps outlined by the turbine manufacturer in starting and stopping the turbine.

5.9 Most of the steps listed for starting and stopping centrifugal pumps are equally applicable to positive-displacement pumps. There are, however, a few notable exceptions, namely,

- a) Never operate a positive-displacement pump against a closed discharge. If the discharge valve must be closed, always start a positive-displacement pump with the recirculation bypass valve open.
- b) Always open the steam-cylinder drain cocks of a steam reciprocating pump before starting, to allow condensate to escape and to prevent damage to the cylinder heads.

6. Restarting Motor-Driven Pumps After Power Failure — In case of motor driven pumps, it is preferable to use starters with low load protection for such installations to prevent an automatic restart. This does not apply if the pumps are automatically primed, or if some protection device is incorporated to avoid dry running of the pump.

APPENDIX A
(Clause 2.1)

PRO FORMA FOR INSPECTION REPORT OF PUMP INSTALLATION AT SITE

Particulars to be Checked	Checked	Initials
A-1. Piping		
A-1.1 Layout, as per drawing		
A-1.2 Hydrostatic test complete		

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Particulars to be Checked	Checked	Initials
A-1.3 Blowing/cleaning complete		
A-1.4 Supports complete (Piping weight not to be supported by pump)		
A-1.5 Insulation (if required), complete		
A-1.6 All blinds and restriction from piping circuit removed		
A-2. Pump temporary strainer fitted pressure gauge for checking delivery pressure		
A-3. Valves on suction and delivery line free to operate and direction of check valve O.K.		
A-4. Alignment with driver complete		
DRIVER	PUMP	RADIAL
		AXIAL
A-5. Driver's direction of rotation checked and pump coupled		
A-6. Lube oil system		
A-6.1 Lube oil/grease filled in bearings		
A-6.2 For high capacity pressure pumps		
a) All oil system pickled; and		
b) Oil pump started and lub oil pressure adjusted		
A-7. Stuffing box		
A-7.1 Mech seal/gland fitted		
A-7.2 Adequate sealing liquid ensured		
A-7.3 Adequate cooling water ensured for high capacity/pressure pumps		
A-7.4 Seal water system cleaned		
A-7.5 Seal water pump started and seal water pressure adjusted		
A-8. For high capacity/pressure pump		
A-8.1 Minimum bypass valve opened		
A-8.2 Balancing drum pressure adjusted/checked as per design		
A-9. Rotor assembly free when coupling rotated by hand		
A-10. Pump casing and suction is full of liquid and air pockets removed (vent valves wherever provided are kept crack open).		
A-11. Delivery valve of pump is closed. To be opened after the pressure is indicated on pressure gauge.		

PUMP IS READY TO START

Note — After the pump is started, all bearings/bushes, amperage, pressure gauges, glands, etc, should be watched for desired working condition as per operation manual supplied with the pump.

Remarks:

Signature of Mech Engineer

Signature of Process Engineer

EXPLANATORY NOTE

One of the important criteria for troublefree running of pumps is the proper operation of the pumps.

This part of the standard lays down the broad guidelines pertaining to operation of pumps for industrial application.

This standard is being issued in the following four parts for its easy reference:

- Part 1 Selection,
- Part 2 Installation,
- Part 3 Operation, and
- Part 4 Maintenance.